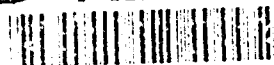


AD-A264 369



(2)

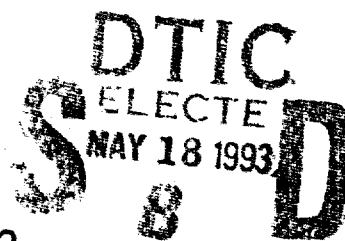
TECHNICAL REPORT
NATICK/TR-93/028

AD _____

BIBLIOGRAPHY: STORAGE STABILITY OF SEMIPERISHABLE SUBSISTENCE ITEMS

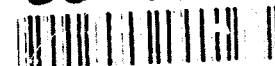
by
Mary T. Friel
Carol P. Shaw
Ramena Means

April 1993
Final Report
October 1991 - October 1992



APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

93-10893



UNITED STATES ARMY NATICK
RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
NATICK, MASSACHUSETTS 01760-5000

FOOD ENGINEERING DIRECTORATE

93 5 17 66 8

Reproduced From
Best Available Copy

DISCLAIMERS

The findings contained in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of trade names in this report does not constitute an official endorsement or approval of the use of such items.

DESTRUCTION NOTICE

For Classified Documents:

Follow the procedures in DoD 5200.22-M, Industrial Security Manual, Section II-19 or DoD 5200.1-R, Information Security Program Regulation, Chapter IX.

For Unclassified/Limited Distribution Documents:

Destroy by any method that prevents disclosure of contents or reconstruction of the document.

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
<small>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.</small>				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE April 1993	3. REPORT TYPE AND DATES COVERED FINAL Oct 1991 - Oct 1992		
4. TITLE AND SUBTITLE Bibliography: Storage Stability of Semiperishable Subsistence Items		5. FUNDING NUMBERS PR 1L162724AH99 TA AH99BB AG MSR1545		
6. AUTHOR(S) Mary T. Friel, Carol P. Shaw, Ramena Means				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Natick Research, Development and Engineering Center SATNC-WTP Natick, MA 01760-5018		8. PERFORMING ORGANIZATION REPORT NUMBER NATICK/TR-93/028		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSORING/MONITORING AGENCY REPORT NUMBER		
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.		12b. DISTRIBUTION CODE		
13. ABSTRACT (Maximum 200 words) This report contains a bibliography of books, technical reports, and scientific papers on the storage stability of semiperishable subsistence items. It includes reports on storage stability studies; sensory and objective methods for evaluating shelf life; and methods of monitoring the physical and chemical changes which occur during storage.				
14. SUBJECT TERMS BIBLIOGRAPHIES STORAGE STABILITY SHELF LIFE STORAGE RATIONS MILITARY RATIONS ENVIRONMENTS			15. NUMBER OF PAGES 28	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT SAR	

TABLE OF CONTENTS

	Page
Preface.....	v
Background.....	1
Purpose.....	2
Organization of References.....	3
Books.....	4
Technical Reports.....	7
Scientific Papers.....	10
Other.....	20
Literature Searches.....	21

PREFACE

This bibliography was compiled under the work unit on Accelerated Testing, Project Number 1L162724AH99, Joint Services Food/Nutrition Technology, in the program entitled Food Stabilization and Shelf Life Indices for Military Feeding at Environmental Extremes. This program was undertaken in the Food Engineering Directorate (FED), Product Development Branch, Food Technology Division of the U.S. Army Natick Research, Development & Engineering Center (Natick). The work was performed under Aggregate Code MSR 1545, Program ID AD94-17, Cost Code 2315725BBOZOO, (AH99BBOZOO) during the period from 1 October 1991 to 1 October 1992. The authors wish to thank Mr. Curtis Blodgett and Ms. Patricia Prell (FED), and Mr. Robert Kluter (Soldier Science Directorate), and the staff at the Technical Library Branch for their assistance in this effort.

DTIC TAB 5

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

BIBLIOGRAPHY: STORAGE STABILITY OF SEMIPERISHABLE SUBSISTENCE ITEMS

Background

The U.S. Department of Defense (DoD) requires rations and other subsistence items to be distributed, stored and used under constantly changing conditions in various environmental extremes. Storage and use of military rations may range from arctic to desert, from temperate climates to jungle locations. Rations must withstand temperatures below freezing, freeze/thaw cycles, temperatures in excess of 120°F, as well as physical abuse from rough handling and the potential for insect infestation.

The normal requirement for semiperishable military rations is that they remain serviceable and acceptable after storage for three years at 80°F. However, many ration components are stable for a longer period. This contrasts with industry practices whereby one year shelf life is considered long term and six months is more typical for the storage of semiperishable subsistence items. Operational rations are stored both in the continental U.S. and around the world in Prepositioned War Reserve Stocks (PWRS) in case of emergency situations. When, as is most often the case, no emergency arises, the rations are rotated out and used for training exercises. However, the amount needed for training purposes is usually less than the amount that should be rotated out.

Operation Desert Shield/Storm (ODS) reemphasized the need for the storage and use of military rations in desert situations. As a result, a program has been undertaken at the U.S. Army Natick Research, Development and Engineering Center (Natick) to address the problems associated with the storage and use of rations around the world, particularly in a high-heat environment. Entitled "Food Stabilization and Shelf Life Indices at Environmental Extremes," the program consists of eight work units. These include Accelerated Testing, Rapid Assessment Measurements, Food Preferences in High Heat, Measuring Heat Stability, Sensory/Analytical Measurements for Rations, Time-Temperature Indicators Correlation, and Nutritional Requirements and Bioavailability. Each work unit addresses an aspect of the development, evaluation, storage, and use of operational rations at environmental extremes.

The Product Development Branch, Food Technology Division of the Food Engineering Directorate at Natick addressed two of the above work units, Accelerated Testing and Rapid Assessment Methods, starting in Fiscal Year 1992. The purpose of the Accelerated Storage work unit is to study the correlation of storage stability of ration components using long term and accelerated storage conditions. With a mandated three year shelf life, any item under development must be stored for a minimum of three years to verify the shelf life, thus necessitating a development time in excess of three years. Although high temperature, shorter storage times are often used for preliminary shelf life testing, little data exist from structured research studies designed to correlate accelerated and long-term storage stability data.

The work unit on Rapid Assessment Methods is designed to establish a simple, rapid, and objective method to determine if a product in storage is acceptable, if it should be used in the near term, or if it should be discarded. In the military, veterinary officers inspect stored rations using statistical sampling (MIL-STD-105) and established guidelines for quality parameters. Although the highly trained inspectors are proficient in assessing food quality after storage, a rapid, definitive, chemical or physical test is preferable to human judgements. With rapid, objective quality determinations, the veterinary inspectors will have the capability to conduct more extensive surveillance inspections to ensure only wholesome rations reach the soldier.

Purpose

The purpose of this report is to publish a bibliography of references on storage stability related to the work units on Accelerated Storage Stability and Rapid Assessment Methods. The bibliography includes studies of the sensory, nutritional, chemical and physical properties and changes found in stored semiperishable food products. It includes procedures to measure quality, including both objective and sensory testing. Listed in the bibliography are books, technical reports, scientific papers, and other references pertaining to the shelf stability of foods and methods of measuring stored food items. Literature searches conducted through the Defense Technical Information Center are included. Because extensive long term and accelerated testing is being conducted on six ration items (applesauce, cheese spread, peanut butter, grape jelly, fig bars, escalloped potatoes with ham), particular attention was given to these products. The authors realize that a totally comprehensive list of all objective and sensory testing of stored food items is neither practical nor achievable. However, the data obtained should be of interest to all concerned with long term storage stability of foodstuffs.

Organization of References

The references for this bibliography are listed alphabetically by reference type under the categories of books, technical reports, scientific papers, others, and literature searches. The literature searches were conducted by the Technical Library Branch, Information Management Directorate at Natick.

**BIBLIOGRAPHY: STORAGE STABILITY OF SEMIPERISHABLE
SUBSISTENCE ITEMS**

1. BOOKS

American Society of Testing and Materials, Standards on Color and Appearance Measurement, 1984, Philadelphia, PA.

American Society of Testing and Materials, ASTM STP 440 Correlation of Subjective-Objective Methods in the Study of Odors and Taste, 1968, Philadelphia, PA.

American Society of Testing and Materials, ASTM STP 594 Correlating Sensory Objective Measurements-New Methods for Answering Old Problems. J.J. Powers and H.R. Moskowitz, editors, 1976, Philadelphia, PA.

American Society of Testing and Materials, ASTM STP 914 Review and Evaluation of Appearance: Methods and Techniques. J.J. Rennilson and W.N. Hale, editors, 1986, Philadelphia, PA.

Baltes, W., Rapid Methods for Analysis of Food and Food Raw Material, Technomic Publishing Co., Lancaster, PA, 1990.

Barnes, H.A., Hutton, J.F., and Walters, K., An Introduction to Rheology, Elsevier Science Publishing Co., Inc., New York, NY, 1989.

Birch, G.G., Brennan, J.G., and Parker, K.J., Sensory Properties of Foods, Applied Science Publishers, Ltd., London, England, 1977.

Bourne, M.C., Food Texture and Viscosity: Concepts and Measurement, Academic Press Inc., New York, NY, 1982.

Cecil, S.R., and Woodroof, J.G., Long Term Storage of Military Rations, Quartermaster Food and Container Institute, 1962.

Charalambous, G., ed., The Shelf Life of Food and Beverages, Proceedings of the 4th International Flavor Conference, Rhodes, Greece, 23-26 July 1985, Elsevier Science Publishing Co., Inc., New York, NY, 1986.

Davidek, J., Velisek, J., and Pokorny, J., Chemical Changes during Food Processing, Elsevier Science Publishing Co., Inc., New York, NY, 1990.

DeMan, J.M., Voisey, P.W., Rasper, V.F., and Stanley, D.W., Rheology and Texture in Food Quality, AVI Publishing Co. Inc., Westport, CT, 1976.

Food Processors Institute, Shelf-Life, A Key to Sharpening Your Competitive Edge, Proceedings, San Francisco, CA, February 18, 1981.

Food Stability Survey, 2 Vols., Department of Food Science, Rutgers University and the U.S. Department of Agriculture, 1971.

Francis, F.J., and Clydesdale, F.M., Food Colorimetry: Theory and Applications, AVI Publishing Co., Inc., Westport, CT, 1975.

Gacula, M.C., and Singh, J., Statistical Methods in Food and Consumer Research, Academic Press Inc., New York, NY, 1984.

Gould, W.A., Food Quality Assurance, AVI Publishing Co., Inc., Westport, CT, 1977.

Hunter, R.S., and Harold, R.W., The Measurement of Appearance, 2nd Edition, John Wiley & Sons, New York, NY, 1987.

Kapsalis, J.G., Objective Methods in Food Quality Assessment, CRC Press, Boca Raton, FL, 1987.

Kramer, A., and Szczesniak, A.S., Texture Measurements in Foods, D. Reidel Publishing Co., Dordrecht-Holland/Boston, MA, 1973.

Labuza, T.P., Shelf-Life Dating of Foods, Food and Nutrition Press, Inc., Westport, CT, 1982.

Larmond, E., Laboratory Methods for Sensory Evaluation of Foods, Research Branch, Department of Agriculture, Ottawa, Canada, Publication 1637, 1987.

Lees, R., The Laboratory Handbook of Methods of Food Analysis, CRC Press, Cleveland, OH, 1968.

MacKinney, G., and Little, A.C., Color of Foods, AVI Publishing Co., Inc., Westport, CT, 1962.

Moskowitz, H.R., Food Texture-Instrumental and Sensory Measurement, Marcel Dekker, Inc., New York, NY, 1987.

Munoz, A.M., Civille, G.V., and Carr, B.T., Sensory Evaluation in Quality Control, Van Nostrand Reinhold, New York, NY, 1992.

Rheology and Texture of Foodstuffs, Joint Symposium Jan 5-6, 1967, British Society of Rheology and Food Group of the Society of Chemical Industry, S.C.I. Monograph No. 27, London, England, 1968.

Stone, H. and Sidel, J.L., Sensory Evaluation Practices, Academic Press, Inc., New York, NY, 1985.

Sutherland, J.P., Varnam, A.H., and Evans, M.G., A Colour Atlas of Food Quality Control, Wolfe Publishing, Inc., The Netherlands, 1986.

Wright, W.D., The Measurement of Color, 3rd Edition, Van Nostrand, Co., Inc., New York, NY, 1964.

2. TECHNICAL REPORTS

Ballinger W., Prell P., Rahman A., Swantak, W., Schafer G., Freeze Dried Compressed Vegetables, Two Year Study, Draft Technical Report, June 1983.

Branagan, M., Effect of Storage on Sensory and Nutritional Quality of Meal, Ready-To-Eat, Individual (MRE I), Draft Technical Report in Review, 1992.

Dickerson, C.E., and Careon, P. CPT, Management of the Marine Corps Inventory of Operational Rations, Center for Naval Analyses, Alexandria, VA, CRC 473, November 1982.

Kalick, J., Gagne, S., Kluter, R., and Strowman, S., Sensory Analysis of Stored Tray Pack Foods, NATICK/TR-90/010, December 1989 (AD A240 795).

Kluter, R., Szeblowski, J., and Branagan, M., An Evaluation of Foods Processed in Tray Pack Versus Two Standard Food Service Containers, Part I: Sensory, Container and Bacteriological Tests, NATICK/TR-86/011, February 1986 (AD A167 187).

Krause, P.F., Report ETL-0152, A Digest of High Temperature Storage Literature, U.S. Army Corps of Engineer Topographic Laboratories, FT Belvoir, VA, July 1978.

McNutt, J.W, and Lee, F.H., Effect of Freeze-Thaw Cycle on Meal, Ready-to-Eat, Individual, 1966 Prototype, NATICK/TR-74-24-FL, February 1974 (AD 776 357).

Morrill, A., Klicka, M.V., Sherman, D.E., Branagan, M.E., and Fossum I., Effects of Storage Time and Temperature on Nutritional Content of Fortified Fruitcake, NATICK/TR-88/018, July 1987 (AD A 191 995).

Norman, E.J., Gaither, R.M., Review of Army Food Related Operations in Hot Desert Environments, NATICK/TR-91/008, February 1991 (AD 232 868).

Porter, W.L., Black, E.D., Kim, Y.K., and Hoke, L., Development of Rapid Methods to Monitor Oxidative and Maillard (Sugar-Amine) Polymerization in Energy-Dense, Encapsulated Model Ration Systems, NATICK/TR-86/063, September 1986 (AD A179 574).

Porter, W.L. and Greenwald, A., Temperature Distribution and Effects of Insulation and Night-Time Ventilation in an Army Warehouse, NATICK TR/71-49-FL, 71-49-ES, January 1971 (AD 728 821).

Porter, W. L. and Greenwald, A., Comparison of the Occurrence of High Temperature in Air and Food in Boxcars in Desert and Humid Subtropical Climates, Yuma, AZ and Cameron Station, VA, NATICK/TR-71-55-FL, 71-55-ES, January 1971 (AD 732 845).

Porter, W.L., and Greenwald, A., The Analysis of High Temperature Occurrences at Selected Internal and Surface Locations in Food Storage Dumps and Isolated Small Cartons at Yuma, AZ, NATICK/TR-71-59-FL, 71-59-ES, January 1971 (AD 736 359).

Prell, P., Young R., Klicka M., Secrist J., McDaniel M., Seven Year Storage Study of B-Ration Dehydrated and Canned Food Products, Draft Technical Report, Food Engineering Directorate, U. S. Army Natick Research, Development & Engineering Center, Natick, MA 01760.

Salunkhe, D.K., Wu, M.T., and Do, D.Y., Long-Term Storage Studies on Dehydrated Ration Items and Food Packets, Utah State University, NATICK/TR-77/004, June 1976 (AD A037 358).

Shaw, C., Young, R., Darsh, G., Secrist, J., Meal, Combat, Individual, Two-Year Storage Study, NATICK/TR-78/026, June 1978 (AD A068 016).

Thomas, M.H., Atwood, B.M., Narayan, K.A., Stability of Vitamins C, B1, B2, and B6 in Fortified Beef Stew, NATICK/TR-86/061, September 1986 (AD A173 815).

Thomas, M.H. and Sherman, D.E. Effect of Freeze-Thaw Cycling on the Vitamin Content of the Meal, Ready-to-Eat, Individual, NATICK/69-86-FL, FL-91, June 1969.

Wyzga, L.A., Klicka, M.V., Kubik, C.A., Szczablowski, J.W., An Evaluation of Foods Processed in Tray Pack versus Two Standard Food Service Containers, Part 2: Nutritional Analyses, NATICK/TR-86/012, February 1986 (AD A170 398).

Quartermaster Research & Development Command, Analogs of Yuma Climate in the Middle East, Yuma Analogs No. 1, Earth Sciences Division, Environmental Research Branch, Natick, MA, March 1954.

Quartermaster Research and Engineering Command, TR EP-118, Southwest Asia: Environment and its Relationship to Military Activities, Environmental Protection Research Division, Natick, MA, July 1959.

U.S. Army Armament Munitions Chemical Command, TR EVT 33-90-1, Operation Desert Storm, Solar Radiation Shielding Materials for Ammunition Storage, Savanna, IL, 61074, February 1991.

U.S. Army Engineer Topographic Laboratories, TR ETL-TR-74-5,
Weather Extremes Around the World, (Revision of NLABS Report
TR-70-45-ES), Ft. Belvoir, VA, 22060, April 1974.

U.S. Army Research Institute of Environmental Medicine,
Environmental Medicine Support for Desert Operations: Practical
Guidance and Suggestions for Deployment and Survival, Natick, MA
01760, August, 1990.

3. SCIENTIFIC PAPERS

Abbink, J., Shelf Life of Compounded Chocolate. Confectionery Manufacture and Marketing 21(10), 16, 1984.

Arya, S.S., Narasimha Murthy, M.C., and Thakur, B.R., Relative Suitability of Various Methods for Determining Free Fatty Acid Levels in Food. J. Food Quality 11(3), 205-211, 1988.

Berger, K.G., Practical Applications of Accelerated Stability Test to Rancidity Problems in Food Processing. J. of Food Technology 6(3) 253-263, 1971.

Best, D., Preservatives--Now You See Them, Now You Don't. Prepared Foods 159(9), 113-118, 1990.

Bishop, J.R., White, C.H., Assessment of Dairy Product Quality and Potential Shelf Life - A Review. J. of Food Protection 49(9) 739-753, 1986.

Bourne, M.C., Limitations of Rheology in Food Texture Measurements. J. Texture Studies 8, 219-227, 1977.

Bourne, M.C., Is Rheology Enough for Food Texture Measurement? J. Texture Studies 6, 259-262, 1975.

Brandt, M.A., Skinner, E.Z. and Coleman, J.A., Texture Profile Method. J. Food Science 28(4), 404-409, 1963.

Brenner, S., Wodicka, V.O., and Dunlop, S.G., Effect of High Temperature Storage on the Retention of Nutrients in Canned Foods. Food Technology 2(3), 207-221, 1948.

Cardello, A.V., Maller, O., Kapsalis, J.G., Segars, R.A., Sawyer, F.M., Murphy, C., and Moskowitz, H.R., Perception of Texture by Trained and Consumer Panelists. J. Food Science 47(4), 1186-1197, 1982.

Cecil, S.R., and Woodroof, J.G., The Stability of Canned Foods in Long-Term Storage. Food Technology 17(5), 131-138, 1963.

Christensen, C.M., Effects of Color on Aroma, Flavor and Texture Judgements of Food. J. Food Science 48(3) 787-790, 1983.

Clydesdale, F.M., Instrumental Techniques for Color Measurement of Food. Food Technology 30(10), 52-59, 1976.

Clydesdale, F.M., Measuring the Color of Foods. Food Technology 26(7) 45-51, 1972.

Corey, H., Texture in Foodstuffs, CRC Critical Reviews in Food Technology 1(2), 161-198, 1970.

Delves-Broughton, J., Nisin and Its Uses as a Food Preservative. Food Technology 44(11), 100-117, 1990.

Dethmers, A.E. and Rodriguez, N.C., Food Products Shelf Life: Sensory Panel Evaluations and the Open Dating Issue. Food Product Development 9(4) 96-102, 1975.

Dethmers, A.E., Utilizing Sensory Evaluation to Determine Product Shelf Life. Food Technology 33(9), 40-42, 1979.

Duncan, S.E., Christen, G.L., and Penfield, M.P., Rancid Flavor of Milk: Relationship of Acid Degree Value, Free Fatty Acids, and Sensory Perception. J. Food Science 56(2), 394-397, 1991.

Dunlop, S.G., Open Storage of Foods in Desert Climate. Food Technology, 72-80, 1947.

Eckerle, J.R., Harvey, C.D., Chen, T.S., Life Cycle of Canned Tomato Paste: Correlation Between Sensory and Instrumental Testing Methods. J. Food Science 49(4) 1188-1193, 1984.

Fagain, Ciaran O., Sheehan, H. and O'Kennedy, R., Accelerated Degradation Testing, American Biotechnology Laboratory, pp 31-32.

Ford, J.E., Hurrell, R.F., and Finot, P.A., Storage of Milk Powders Under Adverse Conditions. Brit. J. Nutrition 49(3), 355-364, 1983.

Friedman, H.H., Whitney, J.E., and Szczesniak, A.S., The Texturometer - A New Instrument for Objective Texture Measurement. J. Food Science 28(4), 390-396, 1963.

Gacula, M.C. Jr., The Design of Experiments for Shelf Life Study. J. Food Science 40(2), 399-403, 1975.

Gacula, M.C. Jr., and Kubala, J.J., Statistical Models for Shelf Life Failures. J. Food Science 40(2), 404-409, 1975.

Griffiths, N., Sensory Analysis in Measuring Shelf Life. Food, Flavours, Ingredients, Packaging and Processing 7(9) 47-48, 1985.

Haralampu, S.G., et al, Estimation of Arrhenius Model Parameters Using Three Least Square Methods. J. Food Processing and Preservation 9(3), 129-143, 1985.

Hao, D.Y.Y., Heaton, K., and Beuchat, L.R., Microbial, Compositional, and Other Quality Characteristics of Pecan Kernels Stored at -20C for Twenty-Five Years. J. Food Science 54(2), 472-474, 1989.

Harris, N.E., Wescott, D.E., Henick, A.S., Rancidity of Almonds: Shelf Life Studies. J. Food Science 37(6) 824-827, 1972.

Harris, N.E., Henick, A.S., Block, I., Wescott, D.E., A Research Note-Stability of Candy Fats. J. Food Science 39(6) 1263-1264, 1974.

Hearne, J.F., Long-Term Storage of Foods. Food Technology 18(3) 318-323, 1964.

Heemskerk, R., The Relationship Between Methods of Conching and Shelf Life: A Case History. Confectionery Manufacture and Marketing 22(12) 13, 16, 1985.

Hellendoorn, E.W., de Groot, A.P., Van der Mijll Dekker, L.P., Slump, P., and Willems, J.J.L., Nutritive Value of Canned Meals. J. American Dietetic Association 58(5), 434-441, 1971.

Henry, W.F., Katz, M.H., Pilgrim, F.J., and May, A.T., Texture of Semi-Solid Foods: Sensory and Physical Correlates. J. Food Science 36(1), 155-161, 1971.

Hill, Charles G. Jr., and Grieger-Block, Richard A., Kinetic Data: Generation, Interpretation, and Use. Food Technology 34(2), 56-66, 1980.

Hollingworth, T.A., Wekell, M.M., Sullivan, J.J., Torkelson, J.D., and Throm, H.R., Chemical Indicators of Decomposition for Raw Surimi and Flaked Artificial Crab. J. Food Science 55(2), 349-352, 1990.

Howard, D.W., A Look at Viscosity. Food Technology 45(7), 82-84, 1991.

Jagnanden, I., The Use of Inverse Gas Chromatography in Accelerated Stability Testing for Products Affected by Temperature and Humidity. Dissertations Abstracts International. B, 42(4) 1376-1377, 1981.

Jowitt, R., The Terminology of Food Texture. J. Texture Studies 5, 351-358, 1974.

Kaletunc, G., Normand, M.D., Johnson, E.A., and Peleg, M., "Degree of Elasticity" Determination in Solid Foods. J. Food Science 56(4), 950-953, 1991.

Kapsalis, J.G., and Moskowitz, H.R., The Psychophysics and Physics of Food Texture, Food Technology 31(4), 91-94, 99, 1977.

Kemp, J.D., Langlois, B.E., Akers, K., and Aaron, D.K., Effect of Storage Temperature, Time and Method of Slicing on Microbial Population and White Film Development in Vacuum Packaged, Dry-Cured Ham Slices. J. Food Science 54(4), 871-873, 1989.

Kemp, J.D., Langlois, B.E., Akers, K., Means, W.J. and Aaron, D.K., Effect of Storage Temperature and Time on the Quality of Vacuum Packaged, Dry-Cured Ham Slices. J. Food Science 53(2), 402-406, 1989.

Kirkwood, T.B.L. and Tydeman, M.S., Design and Analysis of Accelerated Degradation Tests for the Stability of Biological Standards II. A Flexible Computer Program for Data Analysis. J. Biol. Standardization 12, 207-214, 1984.

Kirkwood, T.B.L., Design and Analysis of Accelerated Degradation Tests for the Stability of Biological Standards III. Principles of Design. J. Biol. Standardization 12, 215-224, 1984.

Kirkwood, T.B.L., Predicting the Stability of Biological Standards and Products. Biometrics 33, 736-742, 1977.

Koelsch, C.M., Downes, T.W., and Labuza, T.P. Hexanal Formation via Lipid Oxidation as a Function of Oxygen Concentration: Measurement and Kinetics. J. Food Science 56(3), 816-820, 1991.

Kramer, A., The Relevance of Correlating Objective and Subjective Data. Food Technology 23(7), 66-68, 1969.

Kramer, A., Use of Color Measurement in Quality Control of Foods. Food Technology 30(10), 62-71, 1976.

Krzymien, M.E., and Elias, L., Feasibility Study on the Determination of Fish Freshness by Trimethylamine Headspace Analysis. J. Food Science 55(5), 1228-1232, 1990.

- Kwoleck, W.F., Bookwalter, G.N., Predicting Storage from Time-Temperature Data. Food Technology 25(10) 51-63, 1971.
- Labuza, T.P. and Schmidl, M.K., Accelerated Shelf-Life Testing of Foods. Food Technology 39(9), 57-64, 134, 1985.
- Labuza, T.P., A Theoretical Comparison of Losses in Foods Under Fluctuating Temperature Sequences. J. of Food Science 44(4), 1162-1172, 1979.
- Labuza, T.P., Enthalpy/Entropy Compensation in Food Reactions. Food Technology 34(2), 67-77, 1980.
- Labuza, T.P. and Riboh, D., Theory and Application of Arrhenius Kinetics to the Prediction of Nutrient Losses in Foods. Food Technology 36(10), 66-74, 1982.
- Labuza, T.P., Schmidl, M.K., Use of Sensory Data in the Shelf Life Testing of Foods: Principles and Graphical Methods for Evaluation. Cereal Foods World 33(2), 193-206, 1988.
- Lee, D.S., Chung, S.K., Kim, H.K., and Yam, K.L., Nonenzymatic Browning in Dried Red Pepper Products. J. Food Quality 14(2), 153-163, 1991.
- Lenz, M.K. and Lund, D.B., Experimental Procedures for Determining Destruction Kinetics of Food Components. Food Technology 34(2), 51-53, 1980.
- Little, A.C., Physical Measurements as Predictors of Visual Appearance. Food Technology 30(10), 74-82, 1976.
- MacKinney, G., Little, A.C., and Brinner, L., Visual Appearance of Foods. Food Technology 20, 61-66, 1966.
- Marsh, K.S., Ambrosio, T., and Morton, D.K., Stability Evaluation of a Dynamic System. J. Packaging Technology 2(6), 260-262, 1988.
- Maxcy, R.B., and Wallen, S.E., Heterogeneity of Samples as a Problem in Shelf Life Prediction. J. Food Protection 46(6), 542-544, 1983.
- Mizrahi, S. and Karel, M., Accelerated Stability Tests of Moisture-Sensitive Products in Permeable Packages at High Rates of Moisture Gain and Elevated Temperatures. J. Food Science 42(6), 1575-1579, 1977.
- Molnar, P.J., A Theoretical Model to Describe Food Quality. J. Food Quality 12(1), 1-11, 1989.

Moshy, R.J., Shelf Life: Food Science Considerations from Proceedings, Food Processor's Course, 1981.

Noble, A.C., Instrumental Analysis of the Sensory Properties of Food. Food Technology 29(12), 56-60, 1975.

Nunes, R.V., Rhim, J.W., and Swartzel, K.R., Kinetic Parameter Evaluation with Linearly Increasing Temperature Profiles: Integral Methods. J. Food Science 56(5), 1433-1437, 1991.

Parris, N., Barford, R.A., White, A.E., and Mozersky, S.M., Effect of Processing Temperature and Storage Time on Nonfat Dry Milk Proteins. J. Food Science 54(5), 1218-1221, 1989.

Peryam, D.R., Consumer Preference Evaluation of Storage Stability of Foods. Food Technology 18(9), 214-217, 1964.

Pivarnik, L.F., Kazantzis, D., Karakoltsidis, P.A., Constantinedes, S., Jhaveri, S.N., and Rand, A.G., Freshness Assessment of Six New England Fish Species Using the Torrymeter. J. Food Science 55(1), 79-82, 1990.

Porter, W.L., Black, E.D., Drolet, A.M., and Kapsalis, J.G., Analytical Use of Fluorescence-Producing Reactions of Lipid- and Carbohydrate-Derived Carbonyl Groups with Amine End Groups of Polyamide Powder, ACS Symposium Series, No. 215, 1983.

Powers, J.J., Using General Statistical Programs to Evaluate Sensory Data. Food Technology 38(6), 74-84, 1984.

Race, S.W., Improved Product Quality through Viscosity Measurement. Food Technology 45(7), 86-88, 1991.

Ragnarsson, J.O., Accelerated Temperature Shelf Life Testing of Antioxidants in Dehydrated and Intermediate Moisture Systems. Dissertation Abstracts International, B. 37(12), 6044-6045, 1977.

Ragnarsson, J.O., Labuza, T.P., Accelerated Shelf Life Testing for Oxidative Rancidity in Foods - A Review. Food Chemistry 2(4), 291-308, 1977.

Rakes, P.A., Hamid-Samimi, M.H., and Swartzel, K.R., Long-Term Storage of Aseptically Processed and Packaged Dairy Fluids. J. Food Quality 10(1), 35-41, 1987.

Rhim, J.W., Nunes, R.V., Jones, V.A., and Swartzel, K.R., Determination of Kinetic Parameters Using Linearly Increasing Temperature. J. Food Science 54(2), 446-450, 1989.

Rhim, J.W., Nunes, R.V., Jones, V.A., and Swartzel, K.R., Kinetics of Color Change of Grape Juice Generated using Linearly Increasing Temperature. J. Food Science 54(3), 776-777, 1989.

Richardson, K.C., Shelf Life of Packaged Foods, CSIRO Food Research Quarterly 36, 1-7, 1976.

Ross, E.W., Klicka, M.V., Kalick, J., and Branagan, M., A Time-Temperature Model for Sensory Acceptance of a Military Ration. J. Food Science 52(6), 1712-1717, 1987.

Ross, E.W., Klicka, M.V., Kalick, J., and Branagan, M., Acceptance of a Military Ration after 24-Month Storage. J. Food Science 50(1), 178-208, 1985.

Saguy, I. and Karel, M., Modeling of Quality Deterioration During Food Processing and Storage. Food Technology 34(2), 78-85, 1980.

Sapers, G.M., Flavor and Stability of Dehydrated Potato Products. J. Agricultural Food Chemistry 23(6), 1027-1032, 1975.

Sapers, G.M., Panasiuk, O., Talley, F.B., and Shaw, R.L., Flavor Quality and Stability of Potato Flakes, Effects of Raw Material and Processing. J. Food Science 38(4), 586-589, 1973.

Sapers, G.M., Panasiuk, O., Talley, F.B., and Shaw, R.L., Flavor Quality and Stability of Potato Flakes, Effects of Drying Conditions, Moisture Content and Packaging. J. Food Science 39(3), 555-558, 1974.

Sensory Evaluation Guide for Testing Food and Beverage Products, Sensory Evaluation Division of the Institute of Food Technologists, Food Technology 35(11), 50-59, 1981 and 35(4), 16-17, 1981.

Sensory Testing Guide for Panel Evaluation of Foods and Beverages, Committee on Sensory Evaluation of the Institute of Food Technologists, Food Technology 18(8), 25-31, 1964.

Sharp, R.N., Timme, L.K., 1986. Effects of Storage Time, Storage Temperature, and Packaging Method on Shelf Life of Brown Rice. Cereal Chemistry 63(3), 247-251.

Shelf Life of Foods, A Report by the Institute of Food Technologists' Expert Panel on Food Safety and Nutrition and the Committee on Public Information. Food Technology 28(8), 45-48, 1974.

Shellhammer, T.H., and Singh, R.P., Monitoring Chemical and Microbial Changes of Cottage Cheese using a Full-History Time-temperature Indicator. J. Food Science 56(2), 402-406, 1991.

Sidel, J.L. and Stone, H., 1976. Experimental Design and Analysis of Sensory Tests. Food Technology 30(11), 32-38.

Smith, H. R., Objective Measurements of Quality in Foods. Food Technology 1(3), 345-350, 1947.

Steele, C.J., Cereal Fortification-Technological Problems. Cereal Foods World 21(10), 538-540, 1976.

Stone, H., McDermott, B.J., and Sidel, J.L., The Importance of Sensory Analysis for the Evaluation of Quality. Food Technology 45(6), 88-95, 1991.

Szczesniak, A.S., An Overview of Recent Advances in Food Texture Research. Food Technology 31(4), 71-75, 1977.

Szczesniak, A.S., Classification of Textural Characteristics. J. Food Science 28(4), 385-389, 1963.

Szczesniak, A.S., Correlations Between Objective and Sensory Texture Measurements, Food Technology 22(8), 49-54, 1968.

Szczesniak, A.S., Brandt, M.A., Friedman, H.H., Development of Standard Rating Scales for Mechanical Parameters of Texture and Correlation Between the Objective and the Sensory Methods of Texture Evaluation. J. Food Science 28(4), 397-403, 1963.

Szczesniak, A.S., Objective Measurements of Food Texture. J. Food Science 28(4), 410-420, 1963.

Szczesniak, A.S., The Whys and Whats of Objective Texture Measurements, Canadian Institute of Food Technology J. 2(4), 150-156, 1969.

Szczesniak, A.S., Texture Measurement. Food Technology 20(10), 52-58, 1966.

Szczesniak, A.S., Rheological Problems in the Food Industry. J. Texture Studies 8, 119-133, 1977.

Taoukis, P.S., Fu, B., and Labuza, T.P., Time Temperature Indicators. Food Technology 45(10), 70-82, 1991.

- Taoukis, P.S., and Labuza, T.P., Applicability of Time-Temperature Indicators as Shelf Life Monitors of Food Products. *J. Food Science* 54(4), 783-788, 1989.
- Taoukis, P.S., and Labuza, T.P., Reliability of Time-Temperature Indicators as Food Quality Monitors Under Nonisothermal Conditions, *J. Food Science* 54(4), 789-792, 1989.
- Trant, A.S., Pangborn, R.M., and Little, A.C., Potential Fallacy of Correlating Hedonic Responses with Physical and Chemical Measurements, *J. Food Science* 46(2), 583-588, 1981.
- Tydeman, M.S., Kirkwood, T.B.L., Design and Analysis of Accelerated Degradation Tests for the Stability of Biological Standards I. Properties of Maximum Likelihood Estimators, *J. Biological Standardization*, 12, 195-206, 1984.
- Varsany, I., and Somogyi, L., Determination of the Shelf Life of Food Products. *Acta Alimentaria* 12(2), 73-100, 1983.
- Villota, R., Saguy, I., and Karel, M., Storage Stability of Dehydrated Food Evaluation of Literature Data. *J. Food Quality* 3(3), 123-211, 1979.
- Voisey, P.W., Selecting Deformation Rates in Texture Tests. *J. Texture Studies* 6, 253-257, 1975.
- Waletzko, P., and Labuza, T.P., Accelerated Shelf-Life Testing of an Intermediate Moisture Food in Air and in an Oxygen-Free Atmosphere. *J. Food Science* 41(6), 1338-1344, 1976.
- Wells, J.H., and Singh, R. P., A Kinetic Approach to Food Quality Prediction Using Full-History Time-Temperature Indicators. *J. Food Science* 53(6), 1866-1871, 1988.
- Wells, J.H., and Singh, R.P., Application of Time-Temperature Indicators in Monitoring Changes in Quality Attributes of Perishable and Semiperishable Foods. *J. Food Science* 53(1), 148-152, 1988.
- Williams, A.A., Rogers, C.A., and Collins, A.J., Relating Chemical/Physical and Sensory Data in Food Acceptance Studies. *Food Quality and Preference* 1(1), 25-31, 1988.
- Wolfe, K.A., Use of Reference Standards for Sensory Evaluation of Product Quality. *Food Technology* 33(9), 43-44, 1979.
- Wooden, R.P., and Richeson, B.R., Technological Forecasting: The Delphi Technique. *Food Technology* 25(10), 59-62, 1971.

U.S. Marine Corps - Update. The R&D A Link 9(3) 10, 1992.
R&D Associates Newsletter, San Antonio, TX.

Encyclopedia of Food Science and Technology, Military Food, Hui,
Y.H., Editor, J.H. Wiley & Sons, New York, 1992, pg 1777-1789.

Institute of Food Technologists, How To Analyze Sensory Data,
Symposium presented by IFT Sensory Evaluation Division at IFT
Annual Meeting, June 1982. Food Technology 36(11), 75-101, 1982.

Institute of Food Technologists, Textural Aspects of Milk
Components as Food and Food Ingredients, Symposium sponsored by
IFT Dairy Technology Group at IFT Annual Meeting, June 1991.
Food Technology 46(1) 98-125, 1992.

4. OTHER

Carri-Med Americas, Inc., Valley View, OH, Rheology Seminar, February 16-18, 1992, at Burlingame, CA.

Cook College, Rutgers University, Shelf Life of Foods, Short course in Food Science, April 1-3, 1992, New Brunswick, NJ.

Curiale, M.S., Shelf-Life Evaluation Analysis, Scope (Technical Bulletin from Silliker Laboratories) vol. V, Issue 4, December 1990.

Danish Research, Fourth Edition National Shelf Life Directory, Fairfield, NJ, 1990.

Departments of the Army, the Navy, the Air Force, the U.S. Marine Corps, and the Defense Supply Agency, TM 743-200, NAVSANDA PUB 284, AFM 67-3, NAVMC 1101, DSAM 4145.1, Storage and Materials Handling, June 1955, revised 1969.

Department of Defense, DOD 4140.27-M, Shelf-Life Item Management Manual, March 1982.

Department of Defense, DOD 4145.19-R-1, Storage and Warehousing Facilities and Services, September 1979.

Defense Personnel Supply Center, DPSCH 4155.2 Appendix A, Subsistence, Inspection of Meal, Ready-to-Eat (MRE) Rations, Philadelphia, PA, January 1989.

Gaither, R. LTC, Food-Related Concerns in Hot Desert Environments, U. S. Army Natick Pamphlet 40-1, June 1991.

Hunter Associates Laboratory, Inc., Reston, VA, HunterLab Color and Appearance Seminar, December 5-6, 1991, at Boston, MA.

Institute of Food Technologist, Short Course Sensory Evaluation Methods for the Practicing Food Technologist, 1979-1980.

Loh, Jimbay, Rheological Measurements of Foods, Text of lecture in Rheology Seminar, Painesville, OH, October 2-5, 1988.

Tung, M.A., Some Rheological Principles Involved in Food Texture, Unpublished Course Notes, Technical University of Nova Scotia, Halifax, N.S., Canada, 1987.

U.S. Naval Supply Research and Development Facility, Engineering Report No. 2.202021, Dry Provisions, Unit Load Patterns, Project No. NT003-019(a), Washington, D.C., February 1953.

5. LITERATURE SEARCHES

Defense Technical Information Center, Alexandria, VA, DLA
Technical Report Summaries, Food/Shelf Life, Search Control No.
AEP14F, August 28, 1991.

Defense Technical Information Center, Alexandria, VA, DLA
Technical Report Summaries, Accelerated Food Storage, Search
Control No. AEP48C, November 18, 1991.

Defense Technical Information Center, Alexandria, VA, DLA
Technical Report Summaries, Color/Food Products, Search Control
No. AEP57D, November 18, 1991.

Defense Technical Information Center, Alexandria, VA, DLA
Technical Report Summaries, Texture/Food Products, Search
Control No. AEQ02F, November 18, 1991.

Defense Technical Information Center, Alexandria, VA, DLA
Technical Report Summaries, Peanut Oil, Search Control No.
AEN13M, April 21, 1992.

Defense Technical Information Center, Alexandria, VA, DLA
Technical Report Summaries, Rapid Assay Methods/Foods, Search
Control No. AEN03A, April 28, 1992.

Defense Technical Information Center, Alexandria, VA, DLA Work
Unit Summaries, Food/Shelf Life, DTIC Report No. AEP17D, August
28, 1991.

Defense Technical Information Center, Alexandria, VA, DLA Work
Unit Summaries, Accelerated Food Storage, DTIC Report No.
AEP52E, November 18, 1991.

Defense Technical Information Center, Alexandria, VA, DLA Work
Unit Summaries, Color/Food Products, DTIC Report No. AEP59C,
November 18, 1991.

Defense Technical Information Center, Alexandria, VA, DLA Work
Unit Summaries, Texture/Food Products, DTIC Report No. AEQ04E,
November 18, 1991.

Defense Technical Information Center, Alexandria, VA, DLA Work
Unit Summaries, Peanut Oil, DTIC Report No. AEN16I, April 21,
1992.

Defense Technical Information Center, Alexandria, VA, DLA Work
Unit Summaries, Rapid Assay Methods/Foods, DTIC Report No.
AEN06A, April 28, 1992.

Dialog Information Services, Inc., Prints Summary, Food Storage and Heat, User 001802, 5,10, 110, September 4, 1991.

Dialog Information Services, Inc., Prints Summary, Color and Food, User 001802, Files 5,10,110, November 22, 1991.

Dialog Information Services, Inc., Prints Summary, Food Storage at High Temperatures, User 001802, File 5,10,110, November 22, 1991.

Dialog Information Services, Inc., Prints Summary, Texture and Food, User 001802, File 5,10,110, November 22, 1991.

Dialog Information Services, Inc., Prints Summary, Peanut Butter, User 001802, Files 5,10,110, April 13, 1992.

Dialog Information Services, Inc., Prints Summary, Cheese, Applesauce and Grape Jelly, User 001802, Files 5,10,110, May 4, 1992.

Dialog Information Services, Inc., Prints Summary, Cheese Spread, User 001802, Files 5,10,110, May 4, 1992.